Land-based physical and biological environmental mitigation measures of a mega port construction in Thailand

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Abstract. It is undeniable that a mega port is important to the nation's economy and its population. On the other hand, a port construction creates numerous environmental impacts. To achieve sustainable development, environmental mitigation measures need to be strictly followed. Since a mega port is constructed once in many decades, a case study during the port construction, like this article, is very rare. Our article presents how Thailand protects its surrounding environment during the construction of Laem Chabang Port (the biggest container port in the country), phase 3. The phase-3 reclamation construction started in May 2021 and is expected to be completed in 2025. However, only land-based physical and biological environmental mitigation measures are presented because of the page limit. The land-based environmental impacts are mostly related to truck driving, truck exhaust, road maintenance and cleanliness, noise, dust, and vibration. This article shows that the joint-venture contractor of the reclamation project realizes the necessity of caring for society and the environment.

1 Introduction

A mega port is important to the nation's economy and its population. It is well-acknowledged that the mega port increases national gross domestic products, which in turn drives the domestic economy, enhancing people's well-being. Developing a mega port is not an easy task, because many processes are involved such as port planning, and studying environmental impact assessment (EIA) [1], and actually constructing it. The mega port must be appropriately designed to accommodate the increasing future demands. The environmental impacts must be carefully assessed in order to come up with environmental mitigation measures, that are later used for controlling contractors when constructing the mega port. Since the construction of mega ports always involves ocean reclamations, breakwater constructions, and navigational dredging [2], undesirable environmental impacts from such activities always occur [3]. The associated environmental impacts are severe and must be controlled or prevented in order to avoid undesirable environmental consequences.

A mega port construction creates numerous environmental impacts that, if uncontrolled, may harm the surrounding land and marine ecosystems, as well as jeopardize the well-being of coastal communities. Although the types of impact that are created by an ordinary port and a mega port are relatively similar, the magnitude of such impacts of the mega port is much greater. Ports can alter the magnitude and direction of water currents differently, depending on their sizes and permeability of foundation structures [4]. Water stagnation can happen in certain locations within a port basin, inducing anoxic conditions, leading to low water quality, and killing marine animals [5]. Anton et al. [6] assessed the impacts of breakwaters and found that emerged breakwaters could catastrophically impact zoobenthos due to the direct mechanical destruction of habitats and benthic populations. They also mentioned that breakwaters severely affected phytoplankton by reducing the amount of light and sediment resuspension, decreasing the concentration of dissolved oxygen. Palanques et al. [7] who studied the effects of the massive dumping of dredged material during and after the last large Barcelona port expansion, highlighted that the sediment dumping generated frequent (10-19 hours per day), high (>203.2 mg L−1) and short (50-90 min) suspended sediment concentration peak. Unconsolidated sediment left after the dumping was resuspended and advected, generating higher ambient suspended sediment concentrations (0.8-15.0 mg L−1) than before the dumping (0.4-2.0 mg L−1), which lasted several days. A mega port construction and its channel dredging can affect nearby coastlines. Žilinskas et al. [8] concluded that dredging of the entrance channel of the Klaipėda Port interrupted alongshore sediment transport, causing shore erosion on the updrift side of the port jetties. The dredging of the entrance channel caused a change in the wave field, altering existing wave refraction patterns, changing wave height regimes, and eventually altering the sedimentation patterns.

Currently, most literature focuses on managerial aspects during mega port operations, such as increasing the port's throughputs, managing the port's environmental impacts during the operational phase, managing container yards, and reducing sedimentation and dredging. None of them reports the environmental mitigation measures during the mega port's construction phase. One of the main reasons is that the mega port is only constructed once in many decades, making a case study very rare to find. Therefore, this article is novel because it presents what mitigation measures Thailand has implemented during the construction of its mega container port, Laem Chabang Port, the largest container port in the country. In 2023, this mega port is still under construction. All mitigation measures stated in the EIA report have been completely undertaken. Researchers, port operators, researchers, and the general public can use this article if they consider the mitigation measures implemented during the mega port construction adequate. However, since there are 168 mitigation measures but the page space is limited, only the land-based physical and biological environmental mitigation measures of the Laem Chabang port (LCB) construction are presented in this article. The remaining mitigation measures will be presented at other conferences or journals.

2 The study area

Laem Chabang Port Construction Project, Phase 3 of the Port Authority of Thailand is located in Sriracha District, Chonburi Province, Thailand (Figure 1). Its expansion is due to an exceeded capacity of the LCB Port Phase 1 and Phase 2, which have been open since 1991 and 2003, respectively. This is one of the most important projects in the development of the Eastern Economic Corridor (EEC) that the Thai government strategically wants to enhance the national economy. To connect and transport goods to/from CLMV countries (Cambodia, Laos, Myanmar, Vietnam) and southern China, the LCB port is considered an important strategic point in the transportation and distribution of important products of the region.

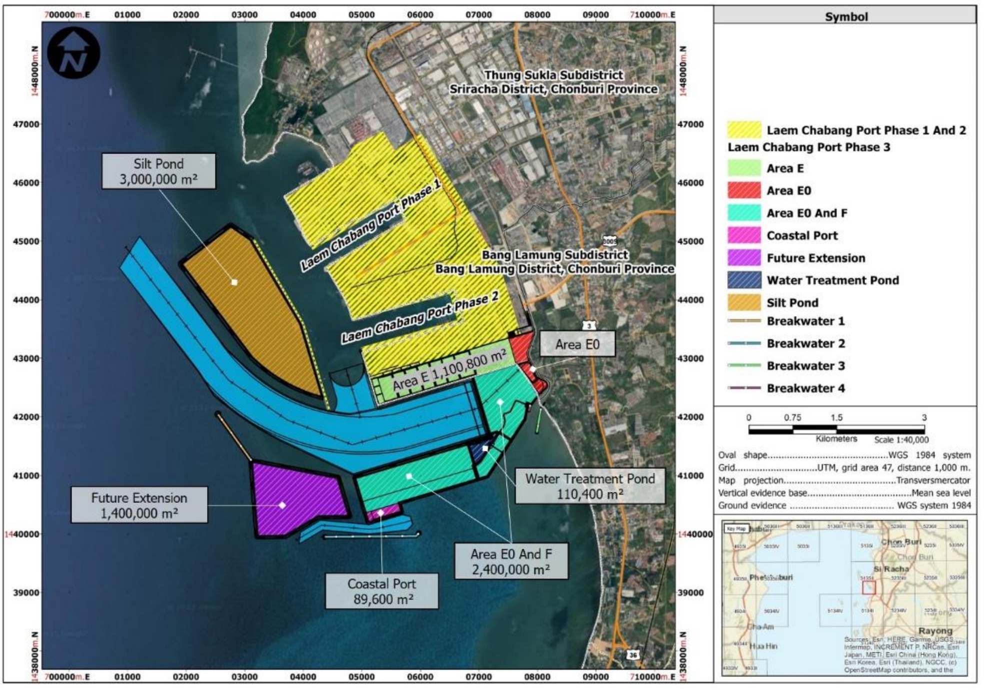

Fig.1. Components of the Laem Chabang Port Construction Project, Phase 3

The development of Laem Chabang Port Phase 3 (LCB p3) is an infrastructure development that covers approximately 8,100,000 sq.m., consisting of a reclamation area, soil quality improvement zone, and future reclamation area. Marine construction work consists of works such as soil quality improvement, dredging and ocean reclamation, rock revetments around the reclamation areas, breakwater construction, floodgate and underpass works, river improvement work, seawater pumping station control, buildings, and installations of navigation aids. The main contractor is a joint venture between China and Thailand partners, named CNNC. The construction started in May 2021 and is expected to be completed in 2025.

3 Environmental impact assessment in Thailand

Environmental impact assessment may be defined as a tool used to forecast or predict impacts that cover both positive and negative dimensions of natural resources, economy and society, that may arise from the development of project activities. It is related and gives importance to the participation of the people who may be affected and various groups of stakeholders to create alternatives for development, and to find ways or measures to control and prevent them.

Environmental impact assessment in Thailand covers 4 categories, also known as the "Four-tier System", which separates environmental resources from their values or qualities in various aspects of human beings as follows:

1. Physical environmental resources (Physical resources) include natural non-living resources such as topography, geology, earthquakes, coastal morphology, oceanography, climate, air quality, noise and vibration, coastal water quality, etc.

2. Biological resources (Biological resources) are resources that occur naturally that are living organisms such as forests, wildlife, plankton, aquatic animals, etc.

3. Human use values (Human use values) is the environmental aspect that arises from the combination of environment, physical resources and biological resources together to benefit humans, such as land use, transportation, fisheries and aquaculture, drainage, waste management, wastewater management, water, electricity consumption, etc.

4. The quality of life value (Quality of life) is the environmental facet that represents the quality of life, when living in the past three groups of the aforementioned environmental aspects, such as socio-economic status, public health, occupational health, safety, scenery and tourism, historical and archaeological sites, etc.

Since most of the LCB port construction activities are in the sea, we have combined the physical and biological presentations together. All environmental mitigation measures are divided into 4 groups as follows: 1. terrestrial physical and biological environmental resources, 2. marine physical and biological environmental resources, 3. Human use value, and 4. quality of life. Only the impacts and mitigation measures related to the terrestrial physical and biological environmental resources are presented in this article.

4 Compliances with the land-based physical and biological environmental mitigation measures

The CNNC joint venture strictly complies with the land-based physical and biological environmental mitigation measures. It firmly believes that reducing the environmental impacts of the constructions will benefit the overall society and environment. In the Environmental and Health Impact Assessment (EHIA) report of the project, there are a total of 24 environmental mitigation measures on the land-based physical and biological resources, consisting of air quality (14 items), noise and vibration (10 items). Details of the land-based physical and biological environmental mitigation measures are as follows:

Air quality (Table 1)

1) Construction areas have fences around the areas that are close to the communities,

2) Spray water to reduce dust at a construction site twice a day, and 4 times a day along the temporary roads,

3) While dumping the construction materials (such as sand soil), water must be sprayed during and after the dumping, and the net must be installed to reduce dust,

4) Check a tray of every truck to be in the good condition, and covered with canvas,

5) Clean roads and construction areas,

6) Check heavy machinery if flue gas is not over the standard,

7) Do not install a ready-mixed plant in the construction area,

8) Workers and officers that have duties outdoor areas must wear clothes or N95 masks,

9) Clean the roads, especially at a connection between construction roads and public roads,

10) Choose the readily-mixed construction materials,

11) Clean wheels and vehicles before leaving the construction area,

12) Listen to air pollution-related topics during the construction phase and use them for improvement,

13) Control truck speed below 40 km/hr in the community's area and below 30 km/hr in the construction area,

14) Control the subcontractor, especially rock transportation from quarries, to abide by EHIA requirements from the rock mines to the construction area

Noise and Vibration (Table1)

1) Construction activities originating loud noise and close to the communities have to operate from 08.00 - 18.00,

2) Try to avoid using heavy machines at the same time,

3) Project site that is close to the community has to install a noise barrier, with a height of 3 meters from ground level and a thickness not less than 0.64 mm., or other materials that can absorb the noise of more than 18 decibels,

4) Use machines and equipment that produce low noise,

5) Use hydraulic hammer type or vibratory pile driver type when piling to reduce noise,

6) Monitor and control noise levels from construction trucks,

7) Maintain roads in good quality to reduce vibration from running trucks,

8) Control truck speed below 40 km/hr in the community's area, and below 30 km/hr in the construction area,

9) Provide personal protective equipment (PPE) (including earplugs) for construction workers and officers, post warning signs in risky areas, and control to use the PPE strictly,

10) Listen to noise pollution-related topics during the construction phase and use them for improvement.

Table 1. Selected photos of land-based environmental mitigation measures being complied

	
The fence around the construction area near the community	The fence in the material storage area
	
Water spraying in the construction area	Water spraying during dumping
	
Covered truck tray during dumping	Covered truck tray during transportation


Truck inspection


Cleaning at intersections with public roads


Inspection of heavy machinery


Use of ready-mixed concrete

Wearing PPE and a mask


Use of finished materials

Wheel cleaning area

Public relations and project contact channels

Toolbox Talk activity

Random speed monitoring

Complaint box	Speed limit signs in project area

5 Discussions

Environmental protection is of utmost importance during port construction. If environmental mitigation measures are ignored, the impact of the construction will deteriorate the environmental quality and eventually affect the community. When a complaint occurs, the construction may be interrupted due to following lawsuits, causing the overall project to be delayed. In addition, protecting the environment during the port construction to ensure that the environment is not damaged leads to faster project completion, because the surrounding communities will provide their support, not quarrels. In the end, communities, industries and the port must flourish together sustainably [9].

In general, there are times when environmental compliance can cause a delay to a port construction project. Complying with environmental measures requires labor, money, time, and understanding [10]. Sub-contractors or workers may not realize the importance of environmental protection measures. For example, sometimes trucks do not cover their trays with canvas, roads within the construction site and intersection points with public roads are not cleaned up, public roads are damaged during rock transportation, and excessive dust levels may occur even though the roads are water-sprayed according to the specified environmental measures, etc. Fulfilling these environmental measures put additional tasks and costs on the construction project [11]. Nevertheless, for this case study, the CNNC joint venture totally realizes the necessity of such environmental measures and strictly follows the EHIA.

The land-based physical and biological environmental measures, associated with the LCB phase 3 reclamation construction are mostly related to the transportation of construction materials and excavations. There are many construction activities such as running trucks, piling, rock stockpiling, dumping, and excavation. These activities cause unavoidable but controllable impacts such as noise, dust, vibration, dirt on the road, and road surface damage, which can disturb the well-being of surrounding communities, especially in terms of human use. Therefore, if the ocean reclamation project does not comply with environmental measures, the surrounding communities will be in pain. This is the reason why the CNNC joint venture recognizes the importance of compliance with the measures, and carefully follows the measures.

In Thailand, environmental measures stated in the EHIA report must be strictly followed. Punishments for non-obedient projects are legally stated in the related laws. The country currently emphasizes on sustainable development, preserving the environment while promoting the national economy. The EIA or EHIA, depending on the types and sizes of the development projects, is a pre-requisite before the Ministry of Finance approves the budget. The EIA is required for marine developments such as piers or ports (accommodating ships over 500 gross tonnages), and ocean reclamations of any size [1]. The EHIA is required for the piers or ports (having a total berth length of more than 300 m., or requiring dredging greater than 100,000 cu.m.). Other types of marine projects that require the EIA are breakwaters of any size, and jetties or groins of any size, because they are considered to create grave impacts on neighboring shorelines and put negative externalities on innocent coastal people [12-13]. In May 2023, Thailand will announce an EIA requirement for every type of coastal revetment because the revetment may create some negative environmental impacts [14].

6 Conclusion

A balance between industrial development and environmental protection is essential. The Laem Chabang Port Construction Project (Phase 3) is important for Thailand's national economic development, while the surrounding environment and the coastal communities are not less important. The port reclamation development without caring for society and the environment is not sustainable because, in the end, the people, the industry, and the environment (the 3 sustainability pillars) must come together. Contractors should not view compliance with environmental mitigation measures as a hindrance to the project. Spending money on following the environmental mitigation measures is cheaper than the amount of money required for lawsuits or environmental remediation, if an undesirable environmental consequence occurs.

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